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MODBUS

MANUAL – CSI SOLAR BRASIL

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CanadianSolar three-phase Inverter RS485 Communication Protocol (Customer version)

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1. Overview

This document describes the external communication protocol of CanadianSolar three-phase grid-connected photovoltaic inverter only.

2. External communication protocols

- Communication interface, RS485;
- Communication parameters: 9600 BPS/N / 8/1;
- Check way: CRC16 - RTU;
- Protocol format: standard MODBUS RTU protocol format;
- The agreement content: CSI three-phase grid inverter external communication protocol;
- Data transmission formats: frame, 5 ~ 256 bytes;
- Response time: 1000 ms (the host sends commands allow from the machine after the longest response time delay).
- Data format: Big end format (Big endian);

3. External communication protocols

3.1 Protocol Frame Format

Start	Address	Function	Data	CRC16-RTU	End
3.5 Char time	1 Byte	1 Byte	N Bytes	2 Byte	3.5 Char time

Table 1 - Protocol frame format

3.2 Address code

The address code is the first byte of communication transmission. Valid slave device address ranges from 0 to 247, and the address range of each slave device ranges from 1 to 247. The host puts the slave address into the address code area of the information frame and addresses it to the slave. When the slave responds, it puts its own address into the address code area of the response information, so that the host can identify the slave address that responds. Address 0 is a broadcast address, which can be identified by all slaves but does not require a reply to the host.

3.3 Function Code

When the host sends a message to the slave, the function code tells the slave the action to be performed. When the slave responds to the host, the function code can indicate that the slave responds normally, or an error occurs. In normal response, the slave replies data according to the corresponding function code; In case of an abnormal response, the slave machine makes an abnormal reply (reply function code +0x80). Legal function codes are defined in the following table:

Function Code	Function Description	Operation register
0x03 (read multiple consecutive registers)		hold registers
0x04 (read multiple consecutive registers)		input registers
0x06 (write a single register)		hold registers
0x10 (write multiple consecutive registers)		hold registers

Table 2 - Definition of function codes

3.4 Data Area

The information data sent by the host to the slave device contains the request actions specified in the function code of the slave machine. If no error occurs, the response message from the slave machine to the host contains the request data. If there is an error, the slave machine does not respond.

3.5 Verification Code

CRC16-RTU verification mode is adopted using the standard MODBUS-RTU protocol.

4. Agreement content

In Modbus protocol, the address range of the hold register is 0x0000~0x7FFF; The high 8 bits of its address represent the block address and the low 8 bits represent the register address within the corresponding block. As shown in the following table, the hold register is allocated into several blocks according to the data category, and the address range of each block is specified in the table.

Address range	Data category
0x8000~0x80FF	Grid status Information data area
0x8100~0x81FF	Inverter (AC) Output status information Data area
0x8200~0x82FF	Inverter (PV) Input status information data area
0x8300~0x83FF	Data area of Inverter Internal Status Information
0x8400~0x84FF	Inverter Fault Status Information Data area

Table 3 - Input register block address allocation table

4.1 Input register table - grid status information data area

Register address	Variable description	Coefficient	Unit	Read and write	Data type	Remarks
0x8000	Line voltage Uab	0.1	V	R	S16	
0x8001	Line voltage Ubc	0.1	V	R	S16	
0x8002	Line voltage Uca	0.1	V	R	S16	
0x8003	A phase voltage Ua	0.1	V	R	S16	
0x8004	B phase voltage Ub	0.1	V	R	S16	
0x8005	C phase voltage Uc	0.1	V	R	S16	
0x8006	A-phase grid frequency	0.1	Hz	R	S16	
0x8007	B-phase grid frequency	0.1	Hz	R	S16	
0x8008	C-phase grid frequency	0.1	Hz	R	S16	
0x8009	Grid phase sequence	1	NA	R	S16	0 : NA 1 : plus 2 : minus
0x800A	Power grid voltage unbalance degree	0.1	%	R	S16	
0x800B	Grid system frequency	0.1	Hz	R	S16	50 Hz or 60Hz
0x800C	Voltage between N line and PE ground	1	V	R	S16	
0x8013	Daily power generation	0.1	kwh	R	U16	
0x8014	Daily generating time	0.1	h	R	U16	

0x8015	Total power generation high 16 bits	1	kwh	R	U16	Merge display
0x8016	Total power output is 16 bits lower				U16	
0x8017	Total generating time is 16 bits higher	1	h	R	U16	Merge display
0x8018	Total generating time is 16 digits lower				U16	
0x8019	The meter enables the flag bit	1		R	U16	
0x801A	A-phase voltage of the meter	0.1	V	R	U16	
0x801B	B-phase voltage of the meter	0.1	V	R	U16	
0x801C	C-phase voltage of the meter	0.1	V	R	U16	
0x801D	A-phase current of the meter	0.01	A	R	U16	
0x801E	B-phase current of the meter	0.01	A	R	U16	
0x801F	C-phase current of the meter	0.01	A	R	U16	
0x8020	Meter frequency	0.01	Hz	R	U16	
0x8021	A-B line voltage of the meter	0.1	V	R	U16	
0x8022	C-B line voltage of the meter	0.1	V	R	U16	
0x8023	A-C line voltage of the meter	0.1	V	R	U16	
0x8024	A-phase active power	0.1	kW	R	S16	
0x8025	B-phase active power	0.1	kW	R	S16	
0x8026	C-phase active power	0.1	kW	R	S16	

0x8027	Total active power of the meter	0.1	kW	R	S16	
0x8028	A-phase reactive power of an ammeter	0.1	kvar	R	S16	
0x8029	B-phase reactive power of an ammeter	0.1	kvar	R	S16	
0x802A	C-phase reactive power of an ammeter	0.1	kvar	R	S16	
0x802B	Total reactive power of the meter	0.1	kvar	R	S16	
0x802C	Ammeter A looks at each other in power	0.1	kVA	R	S16	
0x802D	Ammeter B looks at each other in power	0.1	kVA	R	S16	
0x802E	Ammeter C looks at each other in power	0.1	kVA	R	S16	
0x802F	Total apparent power of the meter	0.1	kVA	R	S16	
0x8030	Meter A-phase power factor	0.001		R	S16	
0x8031	Meter B-phase power factor	0.001		R	S16	
0x8032	Meter C-phase power factor	0.001		R	S16	
0x8033	Total power factor of the meter	0.001		R	S16	
0x8034	The current positive total active power of the meter is high	0.1	kWh	R	U16	
0x8035	The current positive total active energy of the meter is low	0.1	kWh	R	U16	
0x8036	The meter is currently high in reverse total active power	0.1	kWh	R	U16	
0x8037	The current reverse total active power level of the meter	0.1	kWh	R	U16	

0x8038	16 bits higher mon power generation	0.1	kWh	R	U16	
0x8039	16 bits lower mon power generation	0.1	kWh	R	U16	
0x803A	16 bits higher year power generation	0.1	kWh	R	U16	
0x803B	16 bits lower year power generation	0.1	kWh	R	U16	
0x803C	16 bits higher week power generation	0.1	kWh	R	U16	
0x803D	16 bits lower week power generation	0.1	kWh	R	U16	

Table 4 - Grid state information data area

4.2 Input Register table - Inverter (AC) output status information data area

Register address	Variable description	Coefficient	Unit	Read and write	Data type	Remarks
0x8100	A phase current Ia	0.1	A	R	S16	
0x8101	B phase current Ib	0.1	A	R	S16	
0x8102	C phase current Ic	0.1	A	R	S16	
0x8103	Phase A active power	0.1	KW	R	S16	
0x8104	Phase B active power	0.1	KW	R	S16	
0x8105	Phase C active power	0.1	KW	R	S16	
0x8106	Total active power of three phases	0.1	KW	R	S16	
0x8107	A-phase reactive power	0.1	KVar	R	S16	

0x8108	B-phase reactive power	0.1	KVar	R	S16	
0x8109	C-phase reactive power	0.1	KVar	R	S16	
0x810A	Total reactive power of three phases	0.1	KVar	R	S16	
0x810B	A-phase power factor	0.01	NA	R	S16	
0x810C	B-phase power factor	0.01	NA	R	S16	
0x810D	C-phase power factor	0.01	NA	R	S16	
0x810E	Three-phase power factor	0.01	NA	R	S16	
0x810F	Inverter A phase voltage	0.1	V	R	S16	
0x8110	Inverter B phase voltage	0.1	V	R	S16	
0x8111	Inverter C phase voltage	0.1	V	R	S16	

Table 5 - Inverter (AC) output status information data area

4.3 Input Register Table - Inverter (PV) input status information data area

Register address	Variable description	Coefficient	Unit	Read and write	Data type	Remarks
0x8200	PV connection mode	1	NA	R	S16	1- independent, 2- parallel
0x8201	PV Total input power	0.1	KW	R	S16	
0x8202	PV1 voltage	0.1	V	R	S16	
0x8203	PV1 current	0.1	A	R	S16	
0x8204	PV2 voltage	0.1	V	R	S16	

0x8205	PV2 current	0.1	A	R	S16	
0x8206	PV3 voltage	0.1	V	R	S16	
0x8207	PV3 current	0.1	A	R	S16	
0x8208	PV4 voltage	0.1	V	R	S16	
0x8209	PV4 current	0.1	A	R	S16	
0x820A	PV5 voltage	0.1	V	R	S16	
0x820B	PV5 current	0.1	A	R	S16	
0x820C	PV6 voltage	0.1	V	R	S16	
0x820D	PV6 current	0.1	A	R	S16	
0x820E	PV7 voltage	0.1	V	R	S16	
0x820F	PV7 current	0.1	A	R	S16	
0x8210	PV8 voltage	0.1	V	R	S16	
0x8211	PV8 current	0.1	A	R	S16	
0x8212	PV9 voltage	0.1	V	R	S16	
0x8213	PV9 current	0.1	A	R	S16	
0x8214	PV10 voltage	0.1	V	R	S16	
0x8215	PV10 current	0.1	A	R	S16	
0x8216	PV11 voltage	0.1	V	R	S16	

0x8217	PV11 current	0.1	A	R	S16	
0x8218	PV12 voltage	0.1	V	R	S16	
0x8219	PV12 current	0.1	A	R	S16	
0x821A	PV13 voltage	0.1	V	R	S16	
0x821B	PV13 current	0.1	A	R	S16	
0x821C	PV14 voltage	0.1	V	R	S16	
0x821D	PV14 current	0.1	A	R	S16	
0x821E	PV15 voltage	0.1	V	R	S16	
0x821F	PV15 current	0.1	A	R	S16	
0x8220	PV16 voltage	0.1	V	R	S16	
0x8221	PV16 current	0.1	A	R	S16	
0x8222	PV17 voltage	0.1	V	R	S16	
0x8223	PV17 current	0.1	A	R	S16	
0x8224	PV18 voltage	0.1	V	R	S16	
0x8225	PV18 current	0.1	A	R	S16	
0x8232	Boost1 Current	0.1	A	R	S16	
0x8233	Boost2 Current	0.1	A	R	S16	
0x8234	Boost3 Current	0.1	A	R	S16	

0x8235	Boost4 Current	0.1	A	R	S16	
0x8236	Boost5 Current	0.1	A	R	S16	
0x8237	Boost6 Current ,	0.1	A	R	S16	
0x8238	Boost7 Current	0.1	A	R	S16	
0x8239	Boost8 Current	0.1	A	R	S16	
0x823A	Boost9 Current	0.1	A	R	S16	

Table 6 - Inverter (PV) input status information data area

4.4 Input register table - Inverter internal status information data area

Register address	Variable description	Coefficient	Unit	Read and write	Data type	Remarks
0x8300	Inverter operation status	1	NA	R	S16	0 - PowerOnMode 1 - PreCheckMode 2 - InvRunMode 3 - FaultMode 4 - ShutMode 5 - BootloaderMode
0x8301	Inverter module temperature	0.1	°C	R	S16	
0x8302	BOOST module temperature	0.1	°C	R	S16	
0x8303	Internal temperature 1 (main ambient temperature)	0.1	°C	R	S16	
0x8306	Insulation impedance detection value (ISO)	1	KΩ	R	S16	
0x8307	Leakage current detection value (GFCI)	1	mA	R	S16	
0x8308	A-phase DC component (DCI)	1	mA	R	S16	
0x8309	B-phase DC component (DCI)	1	mA	R	S16	

0x830A	C-phase DC component (DCI)	1	mA	R	S16	
0x830B	Positive BUS voltage	1	V	R	S16	
0x830C	Negative BUS voltage	1	V	R	S16	
0x830D	Positive and negative BUS voltage	1	V	R	S16	
0x830E	Power-on countdown	1	s	R	S16	
0x830F	ISO sampling circuit detects voltage	1	V	R	S16	
0x8310	Derating flag bit	1		R	S16	
0x831B	Anti countercurrent load limit flag	1		R	S16	

Table 7 - Data area of inverter internal status information

4.5 Input register table - Inverter fault status information data area

Register address	Variable description	Coefficient	Unit	Read and write	Data type	Remarks
0x8400	Internal alarm fault	1	NA	R	U16	
0x8401	Internal recovery fault 1	1	NA	R	U16	
0x8402	Internal recovery fault 2	1	NA	R	U16	
0x8403	Internal recovery fault 3	1	NA	R	U16	
0x8404	Internal recovery fault 4	1	NA	R	U16	
0x8405	Internal recovery fault 5	1	NA	R	U16	

0x8406	Internal recovery fault 6	1	NA	R	U16	
0x8407	Internal recovery fault 7	1	NA	R	U16	
0x8408	Internal permanent fault	1	NA	R	U16	
0x8409	The ARMC communication board is faulty	1	NA	R	U16	

Table 8 - Inverter fault status information data area

4.6 Mains Fault Protection Parameter Area

Register address	Variable description	Coefficient	Unit	Scope of data	Read and write	Data type
0x0000	AC voltage overvoltage level 1 protection voltage threshold percentage	0.01	%	10000~15000	R/W	S16
0x0001	AC voltage overvoltage level 1 protection time	0.01	s	0~32767	R/W	S16
0x0002	AC voltage overvoltage level 2 protection voltage threshold percentage	0.01	%	10000~15000	R/W	S16
0x0003	AC voltage overvoltage level 2 protection time	0.01	s	0~32767	R/W	S16
0x0004	AC voltage overvoltage level 3 protection voltage threshold percentage	0.01	%	10000~15000	R/W	S16
0x0005	AC voltage overvoltage level 3 protection time	0.01	s	0~32767	R/W	S16
0x0006	AC voltage undervoltage level 1 protection voltage threshold percentage	0.01	%	3000~10000	R/W	S16
0x0007	AC voltage undervoltage level 1 protection time	0.01	s	0~32767	R/W	S16
0x0008	AC voltage undervoltage level 2 protection voltage threshold percentage	0.01	%	3000~10000	R/W	S16

0x0009	AC voltage undervoltage level 2 protection time	0.01	s	0~32767	R/W	S16
0x000A	AC voltage undervoltage level 3 protection voltage threshold percentage	0.01	%	3000~10000	R/W	S16
0x000B	AC voltage undervoltage level 3 protection time	0.01	s	0~32767	R/W	S16
0x000C	AC voltage recovery maximum percentage	0.01	%	8000~15000	R/W	S16
0x000D	AC voltage recovery minimum percentage	0.01	%	2000~10000	R/W	S16
0x000E	AC voltage recovery time	0.01	s	0~32767	R/W	S16
0x000F	AC voltage overfrequency level 1 protection	0.01	Hz	50Hz：5000~5500 60Hz：6000~6600	R/W	S16
0x0010	AC voltage overfrequency level 1 protection time	0.01	s	0~32767	R/W	S16
0x0011	AC voltage overfrequency level 2 protection	0.01	Hz	50Hz：5000~5500 60Hz：6000~6600	R/W	S16
0x0012	AC voltage overfrequency level 2 protection time	0.01	s	0~32767	R/W	S16
0x0013	AC voltage overfrequency level 3 protection	0.01	Hz	50Hz：5000~5500 60Hz：6000~6600	R/W	S16
0x0014	AC voltage overfrequency level 3 protection time	0.01	s	0~32767	R/W	S16
0x0015	AC voltage underfrequency level 1 protection	0.01	Hz	50Hz：	R/W	S16

Table 9 - Mains Fault Protection Parameter Area

4.7 Active Power Derating Parameter Area

Register address	Variable description	Coefficient	Unit	Scope of data	Read and write	Data type
0x0100	Grid overvoltage derating trigger value	0.1	V	0~32767	R/W	S16
0x0101	Grid overvoltage derating recovery value	0.1	V	0~32767	R/W	S16

Table 10 - Active Power Derating Parameter Area

4.8 Reactive Power Derating Parameter Area

Register address	Variable description	Coefficient	Unit	Scope of data	Read and write	Data type
0x0200	PF sets the value	0.1	%	-1000~-800 800~1000	R/W	S16

Table 11 - Reactive Power Derating Parameter Area

4.9 Other Parameter Area

Register address	Variable description	Coefficient	Unit	Scope of data	Read and write	Data type
0x050E	Active power deloading percentage setting value	0.1	%	0 ~ 1000	R/W	S16
0x050F	Reactive power percentage setting value	0.1	%	-1000 ~ 1000	R/W	S16
0x051A	Apparent power derating percentage setting value	0.1	%	0~1000	R/W	S16

Table 12 - Other Parameter Area

4.10 Enable Control Parameter Area

Register address	Variable description	Coefficient	Unit	Scope of data	Read and write	Data type
0x0601	Reactive power mode setting	1	NA	0~5	R/W	S16
0x0602	Active power mode setting	1	NA	0~1	R/W	S16
0x0623	ISO detection enable settings	1	NA	0~1	R/W	S16

Table 13 – Enable Control Parameter Area

4.11 Control Command Area

Register address	Variable description	Coefficient	Unit	Scope of data	Read and write	Data type
0x0700	On-off command	1	Hex	on：5555 off：7777	R/W	S16

Table 14 - Control Command Area

4.12 Inverter Basic Information Area DSP

Register address	Variable description	Coefficient	Unit	Scope of data	Read and write	Data type
0x090C	Rated power	1	KW	0~65535	R/W	S16

Table 15 - Inverter Basic Information Area DSP

4.13 Inverter Basic Information Area ARM

Register address	Variable description	Coefficient	Unit	Scope of data	Read and write	Data type
0x0B02	DSPM software version number	1	NA	0～65535	R	U16
0x0B03	ARMS software version number	1	NA	0~65535	R	U16
0x0B04	ARDC software version number	1	NA	0~65535	R	U16
0x0B05	CPLD software version number	1	NA	0~65535	R	U16
0x0B07	sn01~02	1	NA	0~65535	R	U16
0x0B08	sn03~04	1	NA	0~65535	R	U16
0x0B09	sn05~06	1	NA	0~65535	R	U16
0x0B0A	sn07~08	1	NA	0~65535	R	U16
0x0B0B	sn09~10	1	NA	0~65535	R	U16
0x0B0C	sn11~12	1	NA	0~65535	R	U16
0x0B0D	sn13~14	1	NA	0~65535	R	U16
0x0B0E	sn15~16	1	NA	0~65535	R	U16
0x0B0F	sn17~18	1	NA	0~65535	R	U16

0x0B10	sn19~20	1	NA	0~65535	R	U16
0x0B11	The local mailing address	1	NA	0~247	R/W	U16
0x0B24	RTC/year	1			R/W	U16
0x0B25	RTC/month	1			R/W	U16
0x0B26	RTC/day	1			R/W	U16
0x0B27	RTC/hour	1			R/W	U16
0x0B28	RTC/min	1			R/W	U16
0x0B29	RTC/sec	1			R/W	U16

Table 16 - Inverter Basic Information Area ARM

5. fault analysis

Fault type	Fault ID	Bit	Name of fault
Internal recoverable fault	1	Bit0	External Fan Warning
	2	Bit1	Internal Fan Warning
	3	Bit2	
	4	Bit3	EEPROM R/W Warning
	5	Bit4	Input Spd Warning
	6	Bit5	Temp Sensor Warning
	7	Bit6	
	8	Bit7	Output Spd Warning
	9	Bit8	
	10	Bit9	
	11	Bit10	
	12	Bit11	
	13	Bit12	
	14	Bit13	
	15	Bit14	
	16	Bit15	
Internal recoverable fault 1	17	Bit0	Bus Overvolt Err
	18	Bit1	
	19	Bit2	Bus Unbanlance Err
	20	Bit3	Boost Softstart Overtime Err
	21	Bit4	Inv Softstart Overtime Err
	22	Bit5	
	23	Bit6	Boost 1 Curr High Err

	24	Bit7	Grid Line Vol Overvolt Err
	25	Bit8	Grid Phase Vol Overvolt Err
	26	Bit9	Inv Curr High Err
	27	Bit10	Grid Freq High Err
	28	Bit11	Grid Freq Low Err
	29	Bit12	No Utility Err
	30	Bit13	Relay Err
	31	Bit14	Over Temp Err
	32	Bit15	Inv Curr Offset Err
Internal recoverable fault 2	33	Bit0	Inv Vol Offset Err
	34	Bit1	Inv DCI Curr Offset Err
	35	Bit2	Inv DCI High Err
	36	Bit3	Iso Low Err
	37	Bit4	GFCI High Err
	38	Bit5	Freq Detect Err
	39	Bit6	
	40	Bit7	Mini Mcu Err
	41	Bit8	Hardware Inv Overcurr Err
	42	Bit9	Grid Volt unBalance Err
	43	Bit10	
	44	Bit11	Inv Curr unBalance Err
	45	Bit12	Hardware Power Module Err
	46	Bit13	
	47	Bit14	Hardware Bus Overvolt Err
	48	Bit15	GFCI CT Err
Internal recoverable fault 3	49	Bit0	
	50	Bit1	Internal Hardware Err
	51	Bit2	PV Power and Inv Power Diff Err
	52	Bit3	PV2 Rev Connect Err
	53	Bit4	Boost 2 Curr High Err
	54	Bit5	PV2 Volt High Err
	55	Bit6	PV Abnormal Link Err
	56	Bit7	Inv OpenLoop Self Check Err

	57	Bit8	
	58	Bit9	PV1 Rev Connect Err
	59	Bit10	PV1 Volt High Err
	60	Bit11	PV3 Rev Connect Err
	61	Bit12	PV3 Volt High Err
	62	Bit13	
	63	Bit14	
	64	Bit15	
Internal recoverable fault 4	65	Bit0	Hardware 3V3 Low Err
	66	Bit1	Hardware Bst Overcurr Err
	67	Bit2	
	68	Bit3	Hardware Drive Power Err
	69	Bit4	Product Type Err
	70	Bit5	CPLD Information Err
	71	Bit6	PV4 Volt High Err
	72	Bit7	PV4 Rev Connect Err
	73	Bit8	PV5 Volt High Err
	74	Bit9	PV5 Rev Connect Err
	75	Bit10	PV6 Volt High Err
	76	Bit11	PV6 Rev Connect Err
	77	Bit12	PV7 Volt High Err
	78	Bit13	PV7 Rev Connect Err
	79	Bit14	PV8 Volt High Err
	80	Bit15	PV8 Rev Connect Err
Internal recoverable fault 5	81	Bit0	Hardware 5V Low Err
	82	Bit1	GFCI Steady Err
	83	Bit2	Arc Board Err
	84	Bit3	PV Panel Over Size Err
	85	Bit4	Boost3 Curr High Err
	86	Bit5	Cap and Pll Detect Err
	87	Bit6	PV9 Volt High Err
	88	Bit7	PV9 Rev Connect Err
	89	Bit8	R Grid Vol Diff Err
	90	Bit9	S Grid Vol Diff Err
	91	Bit10	T Grid Vol Diff Err
	92	Bit11	R Grid Freq Diff Err
	93	Bit12	S Grid Freq Diff Err
	94	Bit13	T Grid Freq Diff Err
	95	Bit14	GFCI Diff Err
	96	Bit15	Arcing Err

Internal recoverable fault 6	97	Bit0	Boost 4 Curr High Err
	98	Bit1	Boost 5 Curr High Err
	99	Bit2	Boost 6 Curr High Err
	100	Bit3	Boost 7 Curr High Err
	101	Bit4	Boost 8 Curr High Err
	102	Bit5	Boost 9 Curr High Err
	103	Bit6	DSPM ARMS Communication Fault
	104	Bit7	
	105	Bit8	
	106	Bit9	
	107	Bit10	
	108	Bit11	
	109	Bit12	
	110	Bit13	
	111	Bit14	
	112	Bit15	
Internal recoverable fault 7	113	Bit0	
	114	Bit1	
	115	Bit2	
	116	Bit3	
	117	Bit4	
	118	Bit5	
	119	Bit6	
	120	Bit7	
	121	Bit8	
	122	Bit9	
	123	Bit10	
	124	Bit11	
	125	Bit12	
	126	Bit13	
	127	Bit14	
	128	Bit15	
Permanent internal failure	129	Bit0	Bus Overvolt Fault
	130	Bit1	Hardware 3V3 Low Fault
	131	Bit2	Bus unBalance Fault
	132	Bit3	Relay Fault
	133	Bit4	GFCI Steady Fault
	134	Bit5	Hardware Boost Overcurr Fault
	135	Bit6	DCI High Fault

	136	Bit7	Hardware Bus Overvolt Fault
	137	Bit8	Hardware Inv Overcurr Fault
	138	Bit9	Hardware Drive Power Fault
	139	Bit10	
	140	Bit11	
	141	Bit12	Hardware Power Module Fault
	142	Bit13	Internal Hardware Fault
	143	Bit14	Inv OpenLoop Self Check Fault
	144	Bit15	Hardware 5V Low Fault
ARMC failure	145	Bit0	ARMC DSPM Communication Fault
	146	Bit1	PID Hardware Fault
	147	Bit2	PID BUS Voltage Balance Fault
	148	Bit3	PID Load Break Fault
	149	Bit4	PID Load Short Fault
	150	Bit5	ARMC EEPROM Read Fault
	151	Bit6	ARMC EEPROM Write Fault
	152	Bit7	ARMC EEPROM Checksum Fault
	153	Bit8	RTC Hardware Fault
	154	Bit9	SPD Hardware Fault
	155	Bit10	NOR-FLASH Hardware Fault
	156	Bit11	ARMS Upgrade Failed
	157	Bit12	DSPM Upgrade Failed
	158	Bit13	CPLD Upgrade Failed
	159	Bit14	
	160	Bit15	

Table 17 - fault analysis

6. CRC16-RTU verification code

```
const uint8 chCRCHTalbe[] =
    {
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
```

```
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40
};
const uint8 chCRCLTalbe[] =
{


0x00, 0xC0, 0xC1, 0x01, 0xC3, 0x03, 0x02, 0xC2, 0xC6, 0x06, 0x07, 0xC7,
0x05, 0xC5, 0xC4, 0x04, 0xCC, 0x0C, 0x0D, 0xCD, 0x0F, 0xCF, 0xCE, 0x0E,
0x0A, 0xCA, 0xCB, 0x0B, 0xC9, 0x09, 0x08, 0xC8, 0xD8, 0x18, 0x19, 0xD9,
0x1B, 0xDB, 0xDA, 0x1A, 0x1E, 0xDE, 0xDF, 0x1F, 0xDD, 0x1D, 0x1C, 0xDC,
0x14, 0xD4, 0xD5, 0x15, 0xD7, 0x17, 0x16, 0xD6, 0xD2, 0x12, 0x13, 0xD3,
0x11, 0xD1, 0xD0, 0x10, 0xF0, 0x30, 0x31, 0xF1, 0x33, 0xF3, 0xF2, 0x32,
0x36, 0xF6, 0xF7, 0x37, 0xF5, 0x35, 0x34, 0xF4, 0x3C, 0xFC, 0xFD, 0x3D,
0xFF, 0x3F, 0x3E, 0xFE, 0xFA, 0x3A, 0x3B, 0xFB, 0x39, 0xF9, 0xF8, 0x38,
0x28, 0xE8, 0xE9, 0x29, 0xEB, 0x2B, 0x2A, 0xEA, 0xEE, 0x2E, 0x2F, 0xEF,
0x2D, 0xED, 0xEC, 0x2C, 0xE4, 0x24, 0x25, 0xE5, 0x27, 0xE7, 0xE6, 0x26,
0x22, 0xE2, 0xE3, 0x23, 0xE1, 0x21, 0x20, 0xE0, 0xA0, 0x60, 0x61, 0xA1,
0x63, 0xA3, 0xA2, 0x62, 0x66, 0xA6, 0xA7, 0x67, 0xA5, 0x65, 0x64, 0xA4,
0x6C, 0xAC, 0xAD, 0x6D, 0xAF, 0x6F, 0x6E, 0xAE, 0xAA, 0x6A, 0x6B, 0xAB,
0x69, 0xA9, 0xA8, 0x68, 0x78, 0xB8, 0xB9, 0x79, 0xBB, 0x7B, 0x7A, 0xBA,
0xBE, 0x7E, 0x7F, 0xBF, 0x7D, 0xBD, 0xBC, 0x7C, 0xB4, 0x74, 0x75, 0xB5,
0x77, 0xB7, 0xB6, 0x76, 0x72, 0xB2, 0xB3, 0x73, 0xB1, 0x71, 0x70, 0xB0,
0x50, 0x90, 0x91, 0x51, 0x93, 0x53, 0x52, 0x92, 0x96, 0x56, 0x57, 0x97,
0x55, 0x95, 0x94, 0x54, 0x9C, 0x5C, 0x5D, 0x9D, 0x5F, 0x9F, 0x9E, 0x5E,
0x5A, 0x9A, 0x9B, 0x5B, 0x99, 0x59, 0x58, 0x98, 0x88, 0x48, 0x49, 0x89,
0x4B, 0x8B, 0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D, 0x4D, 0x4C, 0x8C,
0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42, 0x43, 0x83,
0x41, 0x81, 0x80, 0x40
};


uint16 Modbus_CRC16(const uint8 * pchMsg, uint16 uDataLen)
{
    uint8 uchCRCHi = 0xFF;
    uint8 uchCRCLo = 0xFF;
    uint16 uIndex;
    while (uDataLen--)
    {

        uIndex = uchCRCLo ^ *pchMsg++ ;
        uchCRCLo = uchCRCHi ^ chCRCHTalbe[uIndex];
        uchCRCHi = chCRCLTalbe[uIndex];
    }
    // ModBus CRC16 Format is "uchCRCLo + uchCRCHi".
    return (((uint16)( uchCRCLo) << 8) | uchCRCHi);
}
```

7. Automatic address allocation function

When the communication address is 0, it is a broadcast instruction. Each device in the subnet needs to report the current device sub-address (0x64 by default) and SN. The upper computer assigns a communication address to each device according to the received device SN to ensure that the communication address of the device in the subnet is unique and not duplicate.

7.1 Broadcast Networking (Address Search)

The upper computer sends the broadcast network instruction and receives the SN and communication address of each device in the subnet. The device response time adopts random number response, and the maximum response time is 3s.

Sending format	Mailing address （1Byte）	Function code （1Byte）	Start address （2Bytes）	Register number （2Bytes）		CRC16 （2Bytes）
Example	0x00	0x35	0x0B 0x07	0x00	0x0B	CRCL CRCH
Response format	Mailing address （1Byte）	Function code （1Byte）	Number of bytes （1Byte）	Subdevice SN （20Bytes）	Sub-device communication address （2Bytes）	CRC16 （2Bytes）
Example	0x64	0x35	0x16	XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX	0x00 0x64	CRCL CRCH

Table 18 - Automatic address allocation function

7.2 Address Assignment (Broadcast Tape Saving)

The host computer assigns communication addresses to each device in the subnet through broadcast instructions, and the sub-devices identify and set their own sub-addresses through SN. The devices whose addresses have been set do not reply to the broadcast networking instructions in 10.1. The procedure is described as follows:

Sending format	Mailing address （1Byte）	Function code （1Byte）	Start address （2Bytes）	Register number （2Bytes）	CRC16 （2Bytes）	Sending format
Example	0x00	0x38	0x0B 0x07	XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX	0x00 0x02	CRCL CRCH
Respons e format	Mailing address （1Byte）	Function code （1Byte）	Number of bytes （1Byte）	Subdevice SN （20Bytes）	Sub-device communication address （2Bytes）	CRC16 （2Bytes）
Example	0x02	0x38	0x16	XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX	0x00 0x02	CRCL CRCH

Table 19 - Address Assignment (Broadcast Tape Saving)

7.3 Single-Node Address Deregistration (Save the Broadcast Tape and Debug It)

The host computer can remove a device from the communication network and restore its address to the default value (0x64). The device whose address has been deregisted can still reply to the broadcast network instruction in 10.1. The procedure is described as follows:

Sending format	Mailing address （1Byte）	Function code （1Byte）	Start address （2Bytes）	Register number （2Bytes）	CRC16 （2Bytes）	Sending format
Example	0x02	0x39	0x0B 0x07	XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX	0x00 0x64	CRCL CRCH
Respons e format	Mailing address （1Byte）	Function code （1Byte）	Number of bytes （1Byte）	Subdevice SN （20Bytes）	Sub-device communication address （2Bytes）	CRC16 （2Bytes）
Example	0x64	0x39	0x16	XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX	0x00 0x64	CRCL CRCH

Table 20 - Single-Node Address Deregistration (Save the Broadcast Tape and Debug It)

7.4 Deregistering a Broadcast Address (Save the Broadcast Tape for Debugging)

By using this command, the host computer can remove all devices from the communication network and restore their addresses to the default value (0x64). The device whose address has been deregisted can still reply to the broadcast network instruction 10.1. The device does not need to reply to this instruction.

Sending format	Mailing address （1Byte）	Function code （1Byte）	Start address （2Bytes）	Fixed value （2Bytes）	CRC16 （2Bytes）
Example	0x00	0x39	0x0B 0x07	0x00 0x64	CRCL CRCH
Respons e format	Mailing address （1Byte）	Function code （1Byte）	Number of bytes （1Byte）	Fixed value （2Bytes）	CRC16 （2Bytes）
No response required					

Table 21 - Deregistering a Broadcast Address (Save the Broadcast Tape for Debugging)